WHAT IS CLAIMED IS:

1. A light source unit that generates light with a single wavelength, said light source unit comprising:

a light generating portion which generates light with a single wavelength;

a fiber group made up of a plurality of optical fibers arranged in parallel on an output side of said light generating portion; and

a light amount control unit which controls light amount emitted from said optical fiber group by individually turning on/off light output from each optical fiber of said optical fiber group.

2. The light source unit according to Claim 1, wherein at least an output end of each of said plurality of optical fibers making up said fiber group is bundled so as to structure a bundle-fiber.

3. The light source unit according to Claim 1, wherein

at least one stage of a fiber amplifier that can perform optical amplification is arranged on a part of each optical path, which is structured including said each optical fiber, and

said light amount control unit performs on/off operation of said light output from said each optical fiber by switching intensity of pumped light from a pumping light source of said fiber amplifier.

4. The light source unit according to Claim 3, wherein said light amount control unit performs said switching of pumped light intensity by selectively setting intensity of pumped light from said pumping light source to one of a predetermined level and a zero level.

5. The light source unit according to Claim 4, wherein said light amount control unit selectively sets said intensity of pumped light from said pumping light source to one of said predetermined level and said zero level by performing on/off operation on said pumping light source.

6. The light source unit according to Claim 3, wherein said light amount control unit performs said intensity switching of said pumped light by selectively setting said pumped light intensity from said pumping light source to one of a predetermined first level and a second level smaller than said first level.

7. The light source unit according to Claim 3, wherein

said each optical path has a plurality of said fiber amplifiers arranged, and

said light amount control unit performs on/off operation of said light output from said each optical fiber by switching intensity of pumped light from a pumping light source of a fiber amplifier arranged at a final stage.

8. The light source unit according to Claim 7, wherein a mode field diameter of said fiber amplifier arranged most downstream directly before said light output is large, when compared with other fiber amplifiers arranged before said fiber amplifier.

9. The light source unit according to Claim 1, said light source further comprising:

a memory unit which has an output intensity map corresponding to an on/off state of light output from said each optical fiber stored in advance, and

said light amount control unit individually turns on/off light output from said each optical fiber based on said output intensity map and a predetermined set light amount.

10. The light source unit according to Claim 9, wherein said output intensity map is made based on dispersion of light output from said each optical fiber measured in advance.

11. The light source unit according to Claim 9, said light source further comprising:

a wavelength conversion portion which converts a wavelength of said light output from said each optical fiber; and

said output intensity map is made with further consideration on light output dispersion due to dispersion in wavelength conversion efficiency, which corresponds to light output from said each optical fiber measured in advance.

12. The light source unit according to Claim 11, wherein said light generating portion generates a single wavelength laser beam within the range of infrared to visible region, and

said wavelength conversion portion emits ultraviolet light which is a harmonic wave of said single wavelength laser beam.

13. The light source unit according to Claim 12, wherein said light generating portion generates a single wavelength laser beam that has a wavelength of around 1.5μm, and

said wavelength conversion portion generates one of an eighth-harmonic wave and a tenth-harmonic wave of said single wavelength laser beam having said wavelength of around 1.5μm.

14. The light source unit according to Claim 1, said light source unit further comprising a wavelength conversion portion, which converts a wavelength of said light output from said each optical fiber.

15. The light source unit according to Claim 14, wherein said light generating portion generates a single wavelength laser beam within the range of infrared to visible region, and

said wavelength conversion portion emits ultraviolet light which is a harmonic wave of said single wavelength laser

beam.

16. The light source unit according to Claim 15, wherein said light generating portion generates a single wavelength laser beam that has a wavelength of around 1.5μm, and

said wavelength conversion portion generates one of an eighth-harmonic wave and a tenth-harmonic wave of said single wavelength laser beam having said wavelength of around 1.5μm.

17. The light source unit according to Claim 1, wherein said light generating portion includes a light source which generates light having a single wavelength and an optical modulator which converts and emits said light from said light source into a pulse light having a predetermined frequency, and

said light amount control unit further controls at least one of a frequency and a peak power of said pulse light emitted from said optical modulator.

18. The light source unit according to Claim 1, said light source unit further comprising a delay portion, which individually delays light output from said plurality of optical fibers respectively so as to stagger said light output temporally.

19. The light source unit according to Claim 1, wherein said light generating portion has a laser light source

to oscillate a laser beam, and said light source unit further comprises:

a beam monitor mechanism which monitors the optical properties of said laser beam related to wavelength stabilizing to maintain a center wavelength of said laser beam to a predetermined set wavelength; and

a wavelength calibration control unit which performs wavelength calibration based on temperature dependence data of detection reference wavelength of said beam monitor mechanism.

20. The light source unit according to Claim 19, said light source further comprising:

a polarization adjustment unit which orderly arranges a polarized state of a plurality of light beams with the same wavelength having passed through said plurality of optical fibers; and

a polarized direction conversion unit which converts all light beams having passed through said plurality of optical fibers into a plurality of linearly polarized light beams that have the same polarized direction.

21. The light source unit according to Claim 20, wherein

at least a fiber amplifier that can perform optical amplification is arranged on a part of each optical path, which is structured including said each optical fiber, and

said fiber amplifier has an optical fiber, which main material is one of phosphate glass and bismuth oxide glass

doped with a rare-earth element, serving as an optical waveguide member.

22. A light source unit that generates light with a single wavelength, said light source comprising:

a light generating portion that has a light source which generates said light with a single wavelength and an optical modulator which converts light from said light source into a pulse light with a predetermined frequency and emits said pulse light;

a light amplifying portion which includes at least one fiber amplifier to amplify said pulse light generated by said light generating portion, and

a light amount control unit which controls light amount output from said fiber amplifier by controlling a frequency of said pulse light emitted from said optical modulator.

23. The light source unit according to Claim 22, said light source unit further comprising:

a memory unit which has an output intensity map corresponding to a frequency of said pulse light entering said light amplifying portion stored, and

said light amount control unit controls said frequency of said pulse light emitted from said optical modulator based on said output intensity map and a predetermined set light amount.

24. The light source unit according to Claim 22, wherein

said light amount control unit further controls a peak power of said pulse light emitted from said optical modulator.

25. The light source unit according to Claim 22, wherein said optical modulator is an electrooptical modulator, and

said light amount control unit controls said frequency of said pulse light by controlling a frequency of voltage pulse impressed on said optical modulator.

26. The light source unit according to Claim 22, wherein said light amplifying portion is arranged in plural and in parallel, and

an output end of each said light amplifying portion is each made up of an optical fiber.

27. The light source unit according to Claim 26, wherein a plurality of said optical fibers that respectively make up said light amplifying portion in plural are bundled so as to structure a bundle-fiber.

28. The light source unit according to Claim 22, said light source unit further comprising a wavelength conversion portion that converts a wavelength of light emitted from said light amplifying portion.

29. The light source unit according to Claim 28, wherein said light generating portion generates a single

wavelength laser beam within a range of infrared to visible region, and

said wavelength conversion portion emits ultraviolet light which is a harmonic wave of said single wavelength laser beam.

30. The light source unit according to Claim 29, wherein

said light generating portion generates a single wavelength laser beam that has a wavelength of around 1.5μm, and

said wavelength conversion portion generates one of an eighth-harmonic wave and a tenth-harmonic wave of said single wavelength laser beam having said wavelength of around 1.5μm.

31. A light source unit that generates light with a single wavelength, said light source unit comprising:

a light generating portion that has a light source which generates light with a single wavelength and an optical modulator which converts light from said light source into a pulse light with a predetermined frequency and emits said pulse light;

a light amplifying portion which includes at least one fiber amplifier to amplify said pulse light generated by said light generating portion; and

a light amount control unit which controls light amount output from said light amplifying portion by controlling a peak power of said pulse light emitted from said optical modulator.

32. The light source unit according to Claim 31, said light source unit further comprising:

a memory unit which has an output intensity map corresponding to intensity of said pulse light entering said light amplifying portion stored, and

said light amount control unit controls said peak power of said pulse light emitted from said optical modulator based on said output intensity map and a predetermined set light amount.

33. The light source unit according to Claim 31, wherein said optical modulator is an electrooptical modulator, and

said light amount control unit controls said peak power of said pulse light by controlling a peak level of voltage pulse impressed on said optical modulator.

34. The light source unit according to Claim 31, wherein said light amplifying portion is arranged in plural and in parallel, and

an output end of each said light amplifying portion is each made up of an optical fiber.

35. The light source unit according to Claim 34, wherein a plurality of said optical fibers that respectively make up said light amplifying portion in plural are bundled so as to structure a bundle-fiber.

36. The light source unit according to Claim 34, said light source unit further comprising a delay portion, which individually delays light output from said plurality of light amplifying portions respectively so as to stagger said light output temporally.

37. The light source unit according to Claim 31, said light source unit further comprising a wavelength conversion portion, which converts a wavelength of light emitted from said light amplifying portion.

38. The light source unit according to Claim 37, wherein

said light generating portion generates a single wavelength laser beam within a range of infrared to visible region, and

said wavelength conversion portion emits ultraviolet light which is a harmonic wave of said single wavelength laser beam.

39. The light source unit according to Claim 38, wherein

said light generating portion generates a single wavelength laser beam that has a wavelength of around 1.5μm, and

said wavelength conversion portion generates one of an eighth-harmonic wave and a tenth-harmonic wave of said single wavelength laser beam having said wavelength of around 1.5μm.

40. The light source unit according to any one of Claims 22 and 31, wherein

said light generating portion has a laser light source serving as said light source that oscillates a laser beam, and said light source unit further comprises:

a beam monitor mechanism which monitors the optical properties of said laser beam related to wavelength stabilizing to maintain a center wavelength of said laser beam to a predetermined set wavelength; and

a wavelength calibration control unit which performs wavelength calibration based on temperature dependence data of detection reference wavelength of said beam monitor mechanism.

41. The light source unit according to Claim 40, wherein

said light amplifying portion is arranged in plural and in parallel, and said light source unit further comprises:

a polarization adjustment unit which orderly arranges a polarized state of a plurality of light beams with the same wavelength having passed through said plurality of optical fibers that respectively structure said plurality of light amplifying portions; and

a polarized direction conversion unit which converts all light beams having passed through said plurality of optical fibers into a plurality of linearly polarized light beams that have the same polarized direction.

42. The light source unit according to Claim 41, wherein

said fiber amplifier has an optical fiber, which main material is one of phosphate glass and bismuth oxide glass doped with a rare-earth element, serving as an optical waveguide member.

43. A light source unit, said unit comprising:

a laser light source which oscillates a laser beam;

a beam monitor mechanism which monitors the optical properties of said laser beam related to wavelength stabilizing to maintain a center wavelength of said laser beam to a predetermined set wavelength; and

a first control unit which performs wavelength calibration based on temperature dependence data of detection reference wavelength of said beam monitor mechanism.

44. The light source unit according to Claim 43, said light source unit further comprising:

an absolute wavelength provision source which provides an absolute wavelength close to said set wavelength, and

said first control unit performs an absolute wavelength calibration to make said detection reference wavelength of said beam monitor mechanism almost coincide with said absolute wavelength provided by said absolute wavelength provision source, and also a set wavelength calibration to make said detection reference wavelength coincide with said set wavelength based on said temperature dependence data.

45. The light source unit according to Claim 44, wherein said beam monitor mechanism includes a Fabry-Perot

etalon,

said temperature dependence data includes data based on measurement results on temperature dependence of a resonance wavelength of said Fabry-Perot etalon, and

said first control unit performs said absolute wavelength calibration and said set wavelength calibration on said detection reference wavelength by controlling a temperature of said Fabry-Perot etalon structuring said beam monitor unit.

46. The light source unit according to Claim 44, wherein

said temperature dependence data further includes data on temperature dependence of a center wavelength of said laser beam oscillated from said laser light source, and

said first control unit performs wavelength control of said laser light source together, when performing said absolute wavelength calibration.

47. The light source unit according to Claim 44, wherein

said absolute wavelength provision source is an absorption cell on which said laser beam is incident, and

said first control unit maximizes absorption of an absorption line closest to said set wavelength of said absorption cell, as well as maximize transmittance of said Fabry-Perot etalon, when performing said absolute wavelength calibration.

48. The light source unit according to Claim 43, said light source unit further comprising a fiber amplifier, which

amplifies said laser beam from said laser light source.

49. The light source unit according to Claim 48, said light source unit further comprising a wavelength conversion unit, which includes a nonlinear optical crystal to convert a wavelength of said amplified laser beam.

50. The light source unit according to Claim 43, said light source unit further comprising a second control unit which feedback controls a wavelength of said laser beam from said laser light source after said set wavelength calibration is completed, based on monitoring results of said beam monitor mechanism which has completed said set wavelength calibration.

51. The light source unit according to Claim 43, said light source unit further comprising:

a plurality of light amplifying portions arranged in parallel that respectively include fiber amplifiers on the output side of said laser light source;

a polarization adjustment unit which orderly arranges a polarized state of a plurality of light beams with the same wavelength having passed through said plurality of optical fibers that respectively structure said plurality of light amplifying portions; and

a polarized direction conversion unit which converts all light beams having passed through said plurality of optical fibers into a plurality of linearly polarized light beams that have the same polarized direction.

52. The light source unit according to Claim 51, wherein said fiber amplifier has an optical fiber, which main material is one of phosphate glass and bismuth oxide glass doped with a rare-earth element, serving as an optical waveguide member.

53. A light source unit, said unit comprising:

a plurality of optical fibers;

a polarization adjustment unit which orderly arranges a polarized state of a plurality of light beams with the same wavelength having passed through said plurality of optical fibers; and

a polarized direction conversion unit which converts all light beams having passed through said plurality of optical fibers into a plurality of linearly polarized light beams that have the same polarized direction.

54. The light source unit according to Claim 53, wherein said polarization adjustment unit polarizes respectively said plurality of light beams having passed through each of said optical fibers into a state nearly circular, and

said polarized direction conversion unit has a quarter-wave plate.

55. The light source unit according to Claim 54, wherein said optical fibers have an almost cylindrical-symmetric structure; and

said polarization adjustment unit polarizes respectively said plurality of light beams incident on each of said optical fibers into a state nearly circular.

56. The light source unit according to Claim 53, wherein said polarization adjustment unit polarizes respectively said plurality of light beams having passed through each of said optical fibers into an elliptic state almost identical, and

said polarized direction conversion unit has a half-wave plate that rotates a plane of polarization and a quarter-wave plate which is optically connected in series to said half-wave plate.

57. The light source unit according to Claim 53, wherein said plurality of optical fibers respectively are optical fibers making up an optical fiber amplifier, which amplifies a plurality of light beams subject to amplifying incident on said plurality of optical fibers, and waveguide said beams subject to amplifying.

58. The light source unit according to Claim 54, wherein said optical fiber is made mainly of one of phosphate glass and bismuth oxide glass doped with a rare-earth element.

59. The light source unit according to Claim 53, wherein said plurality of light beams incident on said plurality of optical fibers are respectively a pulse train.

60. The light source unit according to Claim 53, wherein said plurality of light beams incident on said plurality of optical fibers are respectively a light beam that has been amplified by at least one stage of an optical fiber amplifier before entering said plurality of optical fibers.

61. The light source unit according to Claim 53, wherein said polarization adjustment unit performs polarization adjustment by controlling optical properties of optical components arranged on the optical path further upstream of said plurality of optical fibers.

62. The light source unit according to Claim 53, wherein said plurality of optical fibers are bundled almost in parallel.

63. The light source unit according to Claim 53, said light source unit further comprising a wavelength conversion unit which performs wavelength conversion on light beams emitted from said polarized direction conversion unit by said light beams passing through at least one nonlinear optical crystal.

64. The light source unit according to Claim 63, wherein

light emitted from said plurality of optical fibers is light which wavelength is in one of an infrared and a visible region, and

light emitted from said wavelength conversion unit is

light which wavelength is in an ultraviolet region.

65. The light source unit according to Claim 64, wherein said light emitted from said plurality of optical fibers has a wavelength of around 1547nm, and

said light emitted from said wavelength conversion unit has a wavelength of around 193.4nm.

66. A light source unit, said unit comprising:

a light amplifying unit which includes an optical waveguiding member mainly made of any one of phosphate glass and bismuth oxide glass doped with a rare-earth element, and amplifies incident light; and

a wavelength conversion unit which converts a wavelength of light emitted from said light amplifying unit.

67. The light source unit according to Claim 66, wherein said optical waveguiding member is an optical fiber which has a core to waveguide light, and a cladding arranged in the periphery of said core.

68. The light source unit according to Claim 67, wherein said optical fiber is arranged linearly.

69. The light source unit according to Claim 67, wherein said light amplifying unit further includes at least a container to house said optical fiber.

70. The light source unit according to Claim 66, wherein said wavelength conversion unit includes at least one nonlinear optical crystal to perform wavelength conversion.

71. A wavelength stabilizing control method to maintain a center wavelength of a laser beam oscillated from a laser light source to a predetermined set wavelength, said wavelength stabilizing control method including:

a first step of measuring in advance temperature dependence of a detection reference wavelength of a wavelength detection unit used to detect a wavelength of said laser beam;

a second step of performing an absolute wavelength calibration to make said detection reference wavelength of said wavelength detection unit almost coincide with an absolute wavelength provided from an absolute wavelength provision source, said absolute wavelength close to said set wavelength; and

a third step of setting said detection reference wavelength of said wavelength detection unit to said set wavelength, based on said temperature dependence obtained in said first step.

72. The wavelength stabilizing control method according to Claim 71, wherein

said wavelength detection unit is a Fabry-Perot etalon, and

in said first step, temperature dependence of a resonance wavelength of said wavelength detection unit is measured;

in said second step, said resonance wavelength is made to almost coincide said absolute wavelength by controlling temperature of said wavelength detection unit; and

in said third step, said resonance wavelength is set as said set wavelength by controlling temperature of said wavelength detection unit.

73. The wavelength stabilizing control method according to Claim 72, wherein

said absolute wavelength provision source is an absorption cell on which said laser beam is incident, and

in said second step, absorption of an absorption line closest to said set wavelength of said absorption cell and transmittance of said wavelength detection unit are maximized.

74. The wavelength stabilizing control method according to Claim 71, wherein

in said first step, temperature dependence of said center wavelength of said laser beam is further measured in advance; and

in said second step, a wavelength control of said laser beam is performed together.

75. The wavelength stabilizing control method according to Claim 71, wherein said method further includes a fourth step of controlling a wavelength of said laser beam from said laser light source, based on detection results of said wavelength detection unit which detection reference wavelength

is set to said set wavelength in said third step.

76. The wavelength stabilizing control method according to one of Claims 74 and 75, wherein said wavelength control is performed, by controlling at least one of a temperature and a current supplied to said laser light source.

77. An exposure apparatus which transfers a pattern formed on a mask onto a substrate, said exposure apparatus comprising:

a light generating portion which generates a single wavelength laser beam within a range of infrared to visible region;

a fiber group made up of a plurality of optical fibers arranged in parallel on an output side of said light generating portion;

a light amount control unit which controls light amount emitted from said optical fiber group by individually turning on/off light output from each optical fiber of said optical fiber group;

a wavelength conversion portion which converts a wavelength of said laser beam emitted from said each optical fiber and emits ultraviolet light which is a harmonic wave of said laser beam; and

an illumination optical system which illuminates said ultraviolet light emitted from said wavelength conversion portion onto said mask as an illumination light for exposure.

78. The exposure apparatus according to Claim 77, said exposure apparatus further comprising:

a memory unit which has an output intensity map corresponding to an on/off state of light output from said each optical fiber stored in advance, and

said light amount control unit controls said light amount of said laser beam emitted from said optical fiber group by individually turning on/off light output from said each optical fiber based on said output intensity map and a predetermined set light amount.

79. The exposure apparatus according to Claim 77, wherein

said light generating portion has a light source which generates a laser beam with a single wavelength and an optical modulator which converts light from said light source into a pulse light with a predetermined frequency, and

said light amount control unit further controls light amount of said laser beam emitted from said optical fiber group by controlling a frequency of said pulse light emitted from said optical modulator.

80. The exposure apparatus according to Claim 79, wherein said light amount control unit further controls light amount of said laser beam emitted from said optical fiber group by controlling a peak power of said pulse light emitted from said optical modulator.

81. An exposure apparatus which transfers a pattern formed on a mask onto a substrate, said exposure apparatus comprising:

a light generating portion that has a light source which generates light with a single wavelength and an optical modulator which converts light from said light source into a pulse light with a predetermined frequency and emits said pulse light, and generates a laser beam having a single wavelength within a range of infrared to visible region;

a light amplifying portion which includes at least one fiber amplifier to amplify a pulse light generated in said light generating portion;

a light amount control unit which controls light amount output from said fiber amplifier by controlling a frequency of said pulse light emitted from said optical modulator;

a wavelength conversion portion which converts wavelength of said laser beam emitted from said light amplifying portion and emits ultraviolet light which is a harmonic wave of said laser beam; and

an illumination optical system which illuminates said ultraviolet light emitted from said wavelength conversion portion onto said mask as an illumination light for exposure.

82. The exposure apparatus according to Claim 81, wherein said light amount control unit further controls light amount of said laser beam emitted from said light amplifying portion by controlling a peak power of said pulse light emitted from said optical modulator.

83. An exposure apparatus which transfers a pattern formed on a mask onto a substrate, said exposure apparatus comprising:

a light generating portion that has a light source which generates light with a single wavelength and an optical modulator which converts light from said light source into a pulse light with a predetermined frequency and emits said pulse light, and generates a laser beam having a single wavelength within a range of infrared to visible region;

a light amplifying portion which includes at least one fiber amplifier to amplify a pulse light generated in said light generating portion;

a light amount control unit which controls light amount output from said light amplifying portion by controlling a peak power of said pulse light emitted from said optical modulator;

a wavelength conversion portion which converts a wavelength of said laser beam emitted from said light amplifying portion and emits ultraviolet light which is a harmonic wave of said laser beam; and

an illumination optical system which illuminates said ultraviolet light emitted from said wavelength conversion portion onto said mask as an illumination light for exposure.

84. An exposure apparatus which repeatedly transfers a pattern formed on a mask onto a substrate, said exposure apparatus comprising:

a light generating portion that has a light source which generates light with a single wavelength and an optical modulator which converts light from said light source into a pulse light;

a light amplifying portion which includes at least one fiber amplifier to amplify a pulse light generated in said light generating portion;

a control unit which controls at least one of a frequency and a peak power of said pulse light via said optical modulator in accordance with a position of an area subject to exposure on said substrate, when said substrate is exposed via said mask by irradiating said amplified pulse light on said mask.

85. An exposure apparatus which transfers a pattern formed on a mask onto a substrate, said exposure apparatus comprising:

a light generating portion that has a light source which generates light with a single wavelength and an optical modulator which converts light from said light source into a pulse light;

a light amplifying portion made up of a plurality of optical paths arranged in parallel on an output side of said light generating portion, said optical paths including at least one fiber amplifier to amplify said pulse light; and

a control unit which controls light amount of said pulse light emitted from said light amplifying portion by individually turning on/off light output from said plurality of optical paths respectively, when said substrate is exposed

via said mask by irradiating said pulse light emitted from said light amplifying portion on said mask.

86. The exposure apparatus according to one of Claims 84 and 85, wherein

said light source generates a laser beam in one of an infrared and a visible region, and said exposure apparatus further comprises:

a wavelength conversion portion which converts a wavelength of said pulse light amplified in said light amplifying portion into a wavelength of ultraviolet light.

87. An exposure apparatus which illuminates a mask with a laser beam and transfers a pattern of said mask onto a substrate, said exposure apparatus comprising:

a light source unit that has a laser light source oscillating said laser beam, a beam monitor mechanism which monitors optical properties of said laser beam related to wavelength stabilizing in order to maintain said center wavelength of laser beam at a predetermined set wavelength, and an absolute wavelength provision source which provides an absolute wavelength close to said set wavelength;

a memory unit where a temperature dependence map is stored, said temperature dependence map made up of measurement data on both a center wavelength of said laser beam oscillated from said laser light source and a temperature dependence of a detection reference wavelength of said beam monitor mechanism;

a first control unit which performs an absolute

wavelength calibration to make a detection reference wavelength of said beam monitor mechanism almost coincide with an absolute wavelength provided from said absolute wavelength provision source, and also performs a set wavelength calibration to make said detection reference wavelength coincide with said set wavelength based on said temperature dependence map; and

a second control unit which exposes said substrate via said mask by irradiating said laser beam on said mask, while performing feedback control on a wavelength of a laser beam emitted from said light source unit based on monitoring results of said beam monitor mechanism which has completed said set wavelength calibration.

88. The exposure apparatus according to Claim 87, said exposure apparatus further comprising:

a projection optical system which projects said laser beam outgoing from said mask onto said substrate;

an environmental sensor which measures a physical quantity related to nearby surroundings of said projection optical system; and

a third control unit which calculates a wavelength change amount to cancel out change in image forming characteristics of said projection optical system due to change in said physical quantity from a standard state based on measurement values of said environmental sensor and changes said set wavelength in accordance with said wavelength change amount, each at a predetermined timing after exposure on said substrate by said second control unit has started.

89. The exposure apparatus according to Claim 88, said exposure apparatus further comprising:

an image forming characteristics correction unit which corrects image forming characteristics of said projection optical system, and

said image forming characteristics correction unit corrects change in image forming characteristics excluding change in image forming characteristics of said projection optical system corrected by changing said set wavelength, each time when said set wavelength is changed by said third control unit.

90. The exposure apparatus according to Claim 87, wherein said light source unit further comprises:

a fiber amplifier which amplifies said laser beam from said laser light source; and

a wavelength conversion unit which includes a nonlinear optical crystal to convert a wavelength of said amplified laser beam into a wavelength in an ultraviolet region.

91. An exposure apparatus that exposes a substrate coated with a photosensitive agent with an energy beam, said exposure apparatus comprising:

a beam source which generates said energy beam;

a wavelength changing unit which changes a wavelength of said energy beam emitted from said beam source; and

an exposure amount control unit which controls an

exposure amount provided to said substrate in accordance with an amount of change in sensitivity properties of said photosensitive agent due to a change in wavelength, when said wavelength is changed by said wavelength changing unit.

92. An exposure apparatus which transfers a predetermined pattern onto a substrate by irradiating an exposure beam onto said substrate, said exposure apparatus comprising:

a plurality of optical fibers that emit light which wavelength is in one of an infrared and a visible region;

a polarization adjustment unit which orderly arranges a polarized state of a plurality of light beams with the same wavelength having passed through said plurality of optical fibers;

a polarized direction conversion unit which converts all light beams having passed through said plurality of optical fibers into a plurality of linearly polarized light beams that have the same polarized direction;

a wavelength conversion unit which performs wavelength conversion on light beams emitted from said polarized direction conversion unit by said light beams passing through at least one nonlinear optical crystal to emit light having a wavelength in an ultraviolet region; and

an optical system which irradiates light emitted from said wavelength conversion unit onto said substrate as said exposure beam.

93. An exposure apparatus that forms a predetermined pattern by irradiating an exposure light on a substrate, said exposure apparatus comprising:

a light amplifying unit which includes an optical waveguiding member mainly made of one of phosphate glass and bismuth oxide glass doped with a rare-earth element, and amplifies incident light;

a wavelength conversion unit which converts a wavelength of light emitted from said light amplifying unit; and

an optical system which irradiates light emitted from said wavelength conversion unit onto said substrate as said exposure light.

94. The exposure apparatus according to Claim 93, wherein said optical waveguiding member is an optical fiber, which has a core to waveguide light and a cladding arranged in the periphery of said core.

95. The exposure apparatus according to Claim 93, wherein said wavelength conversion unit generates said exposure light, which has a wavelength of 200nm and under.

96. An exposure method which repeatedly transfers a pattern formed on a mask onto a substrate, said exposure method including:

a first step of amplifying a pulse light using a fiber amplifier at least once;

a second step of exposing an area subject to exposure

on said substrate via said mask by irradiating said amplified pulse light onto said mask; and

a third step of converting a laser beam emitted from a light source to said pulse light and controlling at least one of a frequency and a peak power of said pulse light in accordance with a position of said area subject to exposure on said substrate, prior to said first step.

97. The exposure method according to Claim 96, wherein said fiber amplifier is arranged in plural and in parallel, and

in said first step, said pulse light is amplified by using only selected fiber amplifiers.

98. The exposure method according to Claim 96, wherein said light source generates a laser beam in one of an infrared and a visible region, and said exposure method further includes:

a fourth step of performing wavelength conversion on said amplified pulse light for conversion into an ultraviolet light before said pulse light is irradiated on said mask.

99. An exposure method which forms a predetermined pattern on a substrate by exposing said substrate with a laser beam, said exposure method including:

a first step which sequentially performs sub-steps of;

a first sub-step of measuring a temperature dependence of a detection reference wavelength in a

wavelength detection unit used to detect a wavelength of said laser beam,

a second sub-step of performing absolute wavelength calibration to make said detection reference wavelength of said wavelength detection unit almost coincide with an absolute wavelength provided from an absolute wavelength provision source, said absolute wavelength close to a set wavelength, and

a third sub-step of setting said detection reference wavelength of said wavelength detection unit to said set wavelength, based on said temperature dependence obtained in said first sub-step, and after these sub-steps are completed,

a second step of repeatedly performing exposure on said substrate with said laser beam, while controlling a wavelength of said laser beam from said laser light source based on detection results of said wavelength detection unit which said detection reference wavelength is set at said set wavelength in said third sub-step.

100. The exposure method according to Claim 99, wherein an optical system is further arranged on a path of said laser beam, and said exposure method further includes:

a third step of changing said set wavelength in order to cancel a change in optical performance of said optical system.

101. A making method of an exposure apparatus that forms a predetermined pattern on a substrate by irradiating an

exposure light on said substrate via an optical system, wherein adjustment of properties in said optical system is performed by using light which wavelength belongs to a predetermined bandwidth including a wavelength of said exposure light, said light generated by a light source unit according to any one of Claims 66 to 70.

102. A device manufacturing method including a lithographic process, wherein exposure is performed using said exposure apparatus according to any one of Claims 77 to 85 and Claims 87 to 95 in said lithographic process.

103. A device manufactured using said device manufacturing method according to Claim 102.

104. A device manufacturing method including a lithographic process, wherein exposure is performed using said exposure method according to any one of Claims 96 to 100 in said lithographic process.

105. A device manufactured using said device manufacturing method according to Claim 104.

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